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Coastal Wetland Depletion and Environmental Sustainability in Parts of Obio/Akpor, Rivers State

NKII, LUCKY BARIPARA[1], NSIEGBE, DICKSON KINIKANWO[2], OYE, IDEKI[3]

[1]Research Assistant, Institute of Geoscience and Space Technology (IGST), RSU, Port Harcourt, +2348064356715, E-mail: nkiilukybaripara@gmail.com.
[2]Department of Geography and Environmental Management, University of Port Harcourt, +2348160505308, E-mail: dicksonnsiegbe@gmail.com
[3]Faculty of Environmental Management, Nigerian Maritime University Okerenkoko, Delta State, +2348034520127, E-mail: oye.ijeki@nmu.edu.ng

Abstract Consequent upon increasing urban population, urbanization and urban expansion, there has been drastic encroachment upon urban wetland ecosystems to provide land space for infrastructural development. This study was conducted to examine the factors responsible for wetland depletion, trend in wetland depletion and management measures for environmental sustainability in Obio/Akpor Local Council Area of Rivers State. This study adopted the mixed method research design. 363 respondents and 22 key informants from six wetland communities were purposively selected for the study. Data on trend of wetland changes and depletion were gotten from Landsat images of USGS 2020. Time series, univariate and descriptive statistics were employed in the data analysis. The results shows that wetland loss/depletion between 1990 -2019 was tremendous as total wetland loss was over 40.9 percent of the whole wetland areas, water bodies was depleted by 77.4 percent and the built- ups on converted wetland was 25.3 percent of the whole converted wetland areas. The results also show that human related activities are causes of wetland depletion. The work also depicted that sustainable wetland management practices for environmental sustainability include development control enforcement and the riparian protection and buffer zone vegetation creation. The work recommend for drastic decrease in human activities that deplete wetland and encouragement of efforts that conserve and protect wetland, proper delineation and safeguard of wetland through wetland protection legislation and putting in place of wetland areas as riparian and Ramsar sites.

Keywords Coastland, Wetland, Geographic Information System (GIS), Environmental Sustainability, Obio/Akpor

Introduction

Wetlands are crucial subset of the total ecosystem in the environment. Wetland plays significant role in surface and subsurface water resources sustenance on Earth [1]. The Ramsar Convention (1971) according to Olusola, Muyideen & Abel [2] sees catchments(wetlands) as places of marshy, fen, peat or water, either natural or man-made, perennial or ephemeral, with stagnant or moving water, fresh or saline water, consisting of marine habitat within the depth no more than six (6) meters with low tide. Wetlands are areas or land areas which lie between continental and water systems where the water level is high and the area is submerged by water having more of these attributes: the land supports a periodic growth of hydrophytes; the hydric soil makes up the substrate; the substrate is non – soil and is inundated with water or submerged by shallow water at some time each year during the growing season [3].

Thus, wetlands have characteristics of plants which are adapted to life forms in the hydic soils. Thus, (USEPA, [4]), defined it as an area of land that is inundated by water or with the presence of water at different times or all year round. Kadziya & Chikosha [5] studying wetlands and urban growth relationship in Zinibabwe noted that wetlands serve as sinks to surface water or ground water flows. They are "natural harvesters" of precipitation water.

However, the depletion rate of the wetland ecosystems is alarming and disheartening, resulting to the loss of habits, bio species, bio-diversity loss, preponderance of algal blooms caused by nutrient overload from land adjacent to a wetland, increased sedimentation which impact negatively on natural filtration [6]. It was observed that the earth wetland ecosystems have being negatively impacted upon and depleted significantly, resulting into major decrease in biological resource productivity. The (UNEP, [7]) observed that over seventy four percent of chemical and biological life support systems of the world wetlands have been lost and there was a significant drop in biological functioning and resources generation from eighty two percent in 2002 to lower than forty six percent in 2016 [8].

The world's largest wetlands are the River Amazon Basin, and the West Seberian Plain, the Pantanal Basin which Straddles Brazil, Bolivia and Paraguay in South America, Okavango Delta, the South Africa Ga-Mampa wetland [9]. In Nigeria, there are wetlands in the Niger Delta and the North East areas [10]. Wetlands are situated in cities at the edges of the urbanized fringes and have been encroached upon, converted for urbanization and for development projects and are under unsustainable pressure to provide space for houses and other infrastructural development [11]. This development is farther worsened by the absence of regulatory framework or feable government legislations. This requires support, openness, and aptitude with regards to deciding the most favourable preservation and handling strategies to supply the need and expectations of the current generations and also preserve this fragile ecosystem for the expectations of the coming generations [10].

Considering the economic, environmental, cultural, ecological and other importance of wetlands, enduring wetland management is necessary [12]. Obio/Akpor Council Area of Rivers State has experienced major wetland depletion. These drastic alterations in form of spatio-temporal extent of depletion and depletion of Fauna and flora species is worrisome and of serious concern to environmentalists. Davidson [6] as cited in Eludoyin & Akinola [13], have alerted that the scope of depletion of wetland in Obio/Akpor Local Government Area is between 34–41% which is a challenge to wetland biological diversity, urban environment and ecological stability. Therefore, sustainable wetland management for environmental sustainability in Obio/Akpor Local Government Area is necessary for the benefits of the diverse and enormous wetland resources.

Wetland destruction is also harmful to the economic development of the place. Recreational machinations like wild life watching, fishing and hunting which generate huge revenue and create jobs are no more in existence. Thus, in a fast growing urban settlement like the Obio/Akpor Local Government area, it is necessary to sustainably manage the wetlands to preserve the ecosystem as to promote the peoples wellbeing and environmental welfare. It becomes imperative therefore to sustainably manage the fast degraded wetland ecosystems in the study area. It is against this backdrop that this work focuses on coastal wetland depletion and environmental sustainability in parts of Obio/Akpor, Rivers State.

Literature Review

Nature and Importance of Wetland Ecosystem

The international convention [14] has defined wetland as marshy, fen, water or peat land areas, whether natural or man-made, stable or temporal with stagnant or flowing, fresh or saline water, involving places which does not exceed six meter at low tide [8]. Wetland covers approximately six percent of the earth surface and play significant role in hydrology and include mangrove, peatlands and marshes, rivers and lake, delta, flood-plains and flooded forests, and even coral reefs [14]. Wetland are actually biologically diverse and productive ecosystems and are habitats to varied plants, including floating pondlities, cattalis, cypress, tamarack, and blue spruce [15].

Wetlands support diverse communities of invertebrates, that subsequently promote a broad species of avians and vertebrates. The ecological complexity of the wetlands can be viewed in the interdependencies of the different parts of the wetland where primary consumers from crustaceans, mollusks, and aquatic insects larvae to muskrats, geese, and deer rely on the numerous algae, plants, and detritus for food; for support to a variety of carnivores, including dragonflies, alligators, and osprey and maintains biologically diverse communities of economic and ecologic value [16].

Ramsar [17], sees wetland as lands transitional bordering the landmass and water systems where the surface or the soil is inundated by shallow water. This therefore implies that wetlands posses some qualities such as: the land that supports predominantly hydrophytes; secondly, the substrates in predominantly undrained hydric soil, and lastly, that the substrate is non soil and is water filled or inundated by shallow water.

The National Research council [18], observed that the least properties essentially significant of wetland ecosystem are re current, sustained inundation or saturation at or close to the surface and the preponderance of physical, chemical, and biological features reflective of re current, sustained inundation or saturation. Also NRC [18], noted that common diagnostic wetlands qualities are hydric soils and hydrophytic vegetation. According to Murray [19], for a place to be called a wetland, the area must have:

i. Hydrology that results in wet or flooded soils.
ii. Soils that are dominated by anaerobic processes, and
iii. Biota, particularly rooted vascular flora, that are adjusted to life in flooded, anaerobic environments.

Mmom, Ezekwe, & Chukwu-Okeah [20], have noted that drainage basins are examples of the productive ecological systems on earth today, comparable to rain forest and reefs. This, therefore implies that an immense variety of microbes, plants, insects, amphibians, reptiles, birds fish and mammalians are components of wetland ecological system, a land area that is water filled, either permanent or seasonally such that it takes on the feature of a distinct ecosystem.

Wetlands are of enormous importance ecologically, NRC [18], noted that wetlands play environmentally significant role, principally in the purification of water, flood control, shoreline protection and stability amd protect coastal communities from coastal erosion, Prevent storm water current. Adekoka [21], observed that wetlands occur naturally on every continent except in Antartica, and that it can be constructed artificially as a tool for water management, which may function in developing water fields in sensitive urban design.

Given the above, Cherry [16] noted that the availability of important economic species in wetlands like commercially important fishes and shell fish, including shrimp, blue crap, oysters, salmon, trout, and sea trout rely on, or are linked to healthy wetlands. Mmom *et al* [20] noted that wetlands can be portrayed as a bio supermarkets that provides great volume of food that attract many animal species as the animals used wetland for their life cycle and that dead plants decompose in the water to form small particle of organic matter that feed many small aquatic insects, jelly fish, and small fishes that serve as sustenance for large migratory fishes, reptiles, amphibians, birds and animals, emphasizing that the economic value of wetland for human society are enormous.

Implication of Wetland Depletion

Wetland depletion is occurring at a faster rate today than ever. The rate of depletion, destruction and degradation has increased flood and drought damage, nutrient runoff and aquatic pollution and shoreline erosion, and triggered significant decline in wildlife population [22]. Wetlands was suppose to function as the bio “kidneys” of the landscape, fittering out any water that would otherwise directly run into a water system [13]. The loss of wetlands can cause the channel in water chemistry of major water systems to be distorted making it difficult to fitter out debris with measuring emission from cars, fertilizer and Pesticides use, and animal grazing. There are the possibilities of increasing numbers of pollutants entering our water ways [19].

Tara & Duggan [23], have noted that when pollutants are discharged into the wetland ecosystems, the natural nutrients balance in the system changes, having grave consequences on the function and community composition of those systems [15]. Thus, a well known and very common cases of upstream water nutrient loading having a major effect on down stream in rivers and wetland ecologic systems, as nutrients from fertilizer used on farmland and large amount of sediment from erosion are being washed directly into the surface water bodies, and without wetlands to filler out these components from the water, the nitrate and phosphate, bacteria, and the sediment carried by streams and river system run into the water body and pollute it [15].

Also is alteration in chemistry and morphology of rivers due to the depletion of wetland which will eventually have great consequence on the soil structure, texture leading to flooding such situation that was supposed to be averted if wetland reperian zones were intact [24]. The wetlands depletion is also detrimental to our nation's economy, recreation like fishing, hunting, and wild life watching which generate huge revenue yearly and create jobs to the teeming population [25]. According to Schmidt, Gomes, Gurreiro & Riordan [26], the wetlands of the Great lakes restoration will create huge financial rewards of at least 50 billion dollars and create thousands of jobs. Thus, wetland depletion has caused job loss, poor revenue generation, slow growth in the economy and retarded development, increase poverty, destitution, starvation and hunger [27].

Conceptual Framework on Sustainable Wetland Management

The sustainable wetland management concept takes its root from the sustainable development principle. According to the (World Commission on Environment and Development (WCED), 1987) cited in Mmom [28] in the Brundtland report the concept of sustainable development talks about the provision for the present generation without compromising the fate of the incoming generations in attending to the yearning and desires of the present generation. Thus, sustainability entails a judicious utilization of resources from the wetlands so as to keep their ecologic properties.

The sustained management is dependent on the Ramsar convention provision on wetland [23, 27] which is focused on the preservation and judicious utilization of the wetlands through cooperation of various governments which contribute to sustainable development realization globally. Thus, it is about maintaining the values of wetlands and roles and also deliver services and benefits now and in time to come for human wellbeing [2]. This therefore implies that judicious utilization of wetlands involves promoting, maintaining wetlands worth and status, environmental and socio-economic sustainability, encourages compromise (or trade off) between individuals and collective interest to be advocated.

An ideal conceptual framework for the use and sustained wetlands management was developed in South Africa by UN – Habitat [29]. This framework was formulated with the use of the learning wheel methodology which generates experience – based conceptual framework using experimental methods. This methodology was used in the Limpopo River Basin Project by experts in landuse / landcover planning and inter – Governance institutions for identification of wetland management success factor which serve to provide the model for this study. The success factors was grouped into cornerstones and keyed into learning wheel framework as shown

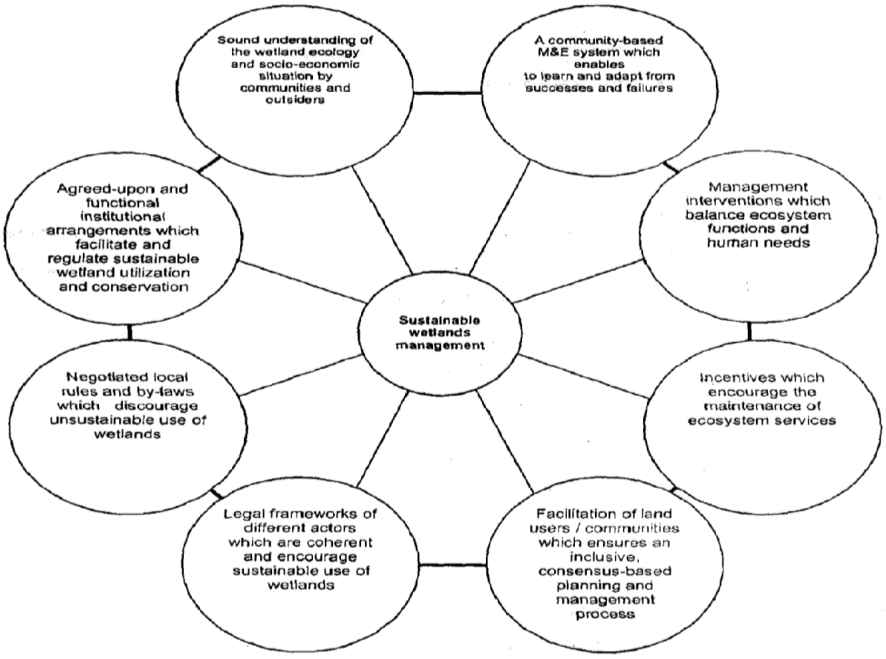

Figure 1: Conceptual Framework for Sustainable Wetlands Management [30]

Eight cornerstones are outlined and are in consonant with the Ramsar convention and include;

i) In-depth comprehension of Ecology of wetlands and social and economic condition of in dwellers and outsiders;
ii) Monitoring and evaluation system based on community that helps to know and adjust from successes;
iii) Interventions by the management which balance ecological system roles and human aspirations;
iv) Motivations which promote the ecological system services maintenance;
v) Legal structures of various participants that are coherent and promotes sustained wetlands utilization.
vi) People agree rules and by – laws that dissuade unprofitable wetlands utilization;
vii) Agreed and functional organization arrangements that help and condition sustained wetland use and preservation.
viii) Land users and communities facilitation that encourages cooperation, planning and management process based on consensus.

Methodology

Study Area

The study area of this research is the coastland of Obio/Akpor Local Government Area situated about 4917.3km from the Atlantic ocean. It futures tropical wet climate with lengthy rainy reason and very short dry season [31]. It has a generally low land area with elevation below 30 metres above the sea level [32], and consist basically of alluvial sedimentary basin and basement complex [28]. It is located within latitudes $4^0$5'11" and 5^o15'45" North and longitudes 6^o22'25" and 8^o05'12" East [32].

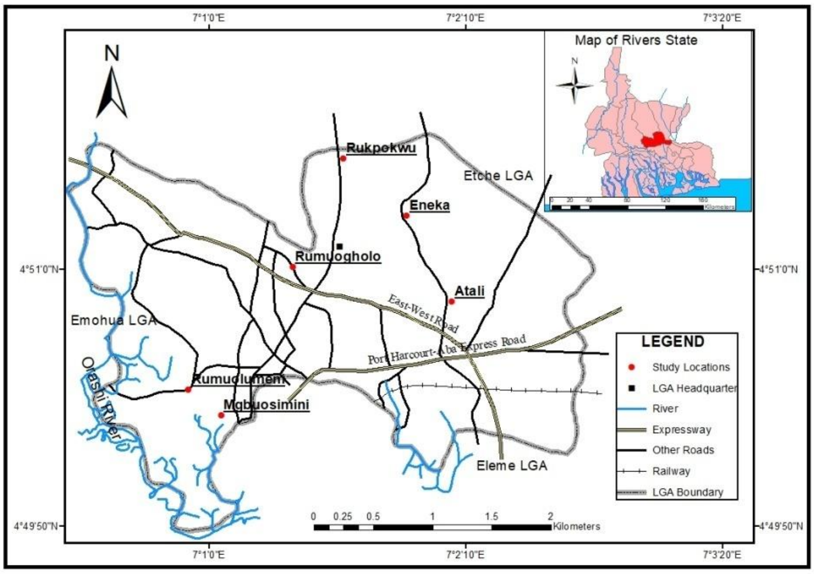

Figure 2: Obio/Akpor and its environs

Source: GIS Lab, Department of Urban and Regional Planning, Rivers State University

Data Sources

This study adopts the mixed method research design were 363 respondents and 22 key informants were purposively selected for questionnaire administration in 6 selected communities of Eneka, Rumawholu, Atali, Rumuolumini, Mgbuoshimini and Rukpokwu. Both qualitative and quantitative data were used. A time series analysis of the spatio dynamics and trend in wetland depletion in Obio/Akpor Local Government was done using Geo-information techniques between 1990-2019 as adopted by Eludoyin & Akinola [13] to examine the spatial and temporal analysis of wetland dynamics in Obio/Akpor Local Government Area. The methodology involves: The L8 OLI/TIRS landsat imageries was downloaded from earthexplorer.usgs.gov, the downloaded landsat bands was imported into ArcMap environment, using the composite bands tool on the image Analysis panel, the different bands were merged into a single raster data, the composite raster image was clipped using

Obo/Akpor local government area boundary, maximum Likelihood, Supervised classification was performed on the clipped Images. The map was classified into; built up Area, wetland and water bodies.
The study areas borders: Eneka, Rukpokwu, Atali, Rumuagholu, Rumuolumeni and Mgbuoshimini were saved from Google earth as a kmz file and transposed to a layer on ArcMap using the Conversion tool. The classified raster image was reclassified and then converted to polygon, where simple arithmetic was done to determine the percentages and size of wetland lost from 1990-2019.

Data Analysis and Results

The analysis of the causes of wetland depletion, trend of wetland depletion from 1990-2019 and the sustainable environmental options is shown. The survey revealed that urban sprawl/urban expansion accounted 11.8% of the interviewed peoples' responses. 13.2% of the people interviewed said it was because of increase in the number of people/rural-urban migration, 13.8% said increased urbanization, 10.5% said it was because of evaporation, 11.4% said that it was because of sedimentation, 12.4% noted that it was because of infrastructural development while 10.2% said that it was because of the industrial Estate Development, and Housing and Facility Development and others (recreational development and timber logging) responsible for 14.3% and 2.3% respectively are the causes for wetland depletion. This is shown in Table 1 below.

Table 1: Distribution of factors responsible for wetland depletion

S/N	Contributors to wetland depletion	F	%
a.	Urban sprawl/urban expansion	42	11.8
b.	Population explosion/rural-urban migration	48	13.2
c.	Increased urbanization	50	13.8
d.	High soil evaporation	38	10.5
e.	Soil sedimentation	41	11.4
f.	Building and construction of infrastructure	45	72.4
g.	Industrial estate development	37	10.2
h.	Housing and facility development	52	14.3
i.	Others (recreational development, timber logging)	10	23
	Total	363	100

Source: Field Survey, 2020

The survey data on the reasons for concern on wetland depletion shows that significant amount of wetland ecosystem has been depleted as 100% of the people interviewed in the selected communities affirmed and that was of serious concern as 25.9% of the respondents noted that wetland is disappearing, 23.7% said that it was diminishing enormously, 24.6% said that it was disappearing greatly and 25.6% said that it rate of lost is spatially and disheartening. This is shown in Table 2.

Table 2: Distribution of reasons for concern on wetland depletion

S/N	Concern for wetland depletion	F	%
a.	Because it is fast disappearing	94	25.9
b.	It is diminishing enormously	86	23.7
c.	It is disappearing greatly	90	24.8
d.	Its rate of host is spatially disheartening	93	25.6
	Total	363	100

Source: Field Survey, 2020

The spatio-temporal changes and trend of wetland depletion

The study from the GIS investigation of the selected communities using Landsat imageries data from 1990 – 2000; 2001 – 2010 and 2011 – 2019 shows that data from the Landsat imageries of 1990, 2000, 2010 and 2019 of Obio/Akpor was acquired from the USGS 2020. The landsat has the ability to monitor, measure and detect humid tropical vegetation and other landuse/landcover at a very high resolutions having spatial resolution of six spectral bands of 30m x 30m, one black and white band of 15m x 15m and a thermal band of resolution of 60m x 60m thick vegetation. Thus, spatial pattern of landcover in 1990, 2000, 2010 and 2019 was shown.

Table 3: Land use spatial pattern and wetland change from 1990-2019

Rumuolumeni	**1990 SqM**	**1990 Per**		**2000 SqM**	**2000 per**		**2010 SqM**	**2010 Per**		**2019 SqM**	**2019 Per**
Wetland	6508084.364	64.4395641	Built Up Area	933626.2518	9.244266874	BuiltUp Area	4151725.01	41.10815639	Wetland	908053.8829	8.99106298
Water Body	3206392.856	31.74798396	Water Body	1258343.084	12.45943895	WetLAnd	2384360.89	23.60866392	Built Up Area	5299483.483	52.47264579
Built Up Area	385039.21	3.812451939	WetLand	7907547.094	78.29629417	Water Body	3563430.53	35.28317968	Water Body	3891979.07	38.53629129
Total	10099516.43	100	Total	10099516.43	100	Total	10099516.4	100	Total	10099516.43	100.0000001
Rumuagholu											
Water Body	1222141.81	12.10099333	BuiltUp Area	1189235.778	11.39491966	BuiltUp Area	4796553.59	45.95921502	wetland	2709331.86	25.96004884
BuiltUp Area	434776.0439	4.304919418	Water Body	16669.8669	0.159725933	WetLand	4652464.1	44.57859037	Water body	51670.01	0.495087369
Wetland	8442598.576	83.59408725	WetLand	9230638.125	88.4453544	Water Body	987526.082	9.462194609	Builtup Area	7675541.9	73.54486379
Total	10099516.43	100	Total	10436543.77		Total	10436543.8	100	Total	10436543.77	100
Rukpokwu											
Water Body	882556.7205	7.004772513	Builtup Area	984384.4711	7.812970119	BuiltUp Area	6651476.29	52.79216305	WetLand	2304661.18	18.29188642
BuiltUp Area	382775.4455	3.038053937	Water Body	37360.142	0.296524053	WetLand	4688328.22	37.21083518	Water Body	7406.49192	0.058784654
WetLand	11334030.89	89.95717352	WetLand	11577618.45	91.89050585	Water Body	1259558.55	9.997001769	BuiltUp Area	10287295.39	81.64932895
Total	12599363.06	100	Total	12599363.06	100	Total	12599363.1	100	Total	12599363.06	100
Mgbuoshimini											
BuiltUp Area	1348234.639	18.20351115	BuiltUp Area	3354196.866	45.28748801	BuiltUp Area	4788874.31	64.65812731	Water Body	1129178.856	15.24587731
WaterBody	1078710.923	14.56447249	WaterBody	576173.3741	7.779342065	Wetland	847086.57	11.43714112	WetLand	256511.3688	3.463349351
WetLand	4979508.214	67.23201635	WetLand	3476083.536	46.93316992	WaterBody	1770492.89	23.90473157	BuildUp Area	6020763.551	81.29077333
Total	7406453.776	100	Total	7406453.776	100	Total	7406453.78	100	Total	7406453.776	100
Eneka											
BuiltUp Area	377572.1937	3.211581086	BuiltUp Area	877768.5401	7.466187627	BuiltUp Area	6334008.46	53.87627082	WetLand	2097893.554	17.8444159
Water Body	70500.2778	0.599666402	Water Body	8097.1617	0.068873428	WetLand	4295894.58	36.54033323	Water Body	14114.00612	0.120051942
WetLand	11308510.46	96.18875253	WetLand	10870717.23	92.46493896	Water Body	1126679.89	9.583395955	Built Up Area	9644575.37	82.03553216
Total	11756582.93	100	Total	11756582.93	100	Total	11756582.9	100	Total	11756582.93	100
Atali											
BuiltUp Area	1021043.213	9.196230709	BuiltUp Area	2422968.338	21.82295084	BuildUp Area	5357817.83	48.25626208	WetLand	3986422.307	35.90451293
Water Body	385179.055	3.469192498	WaterBody	60740.1177	0.547068066	WetLand	5027279.1	45.27919861	Water Body	10621.39	0.095663682
WetLand	9696622.422	87.33457679	WetLand	8619136.234	77.6299811	Water Body	717747.759	6.464539305	Built Up Area	7105800.993	63.99982339
Total	11102844.69	100	Total	11102844.69	100	Total	11102844.7	100	Total	11102844.69	100

The imageries were downloaded and imported into ArcMap environment using the composite bands tool on the image analysis panel, the different bands were merged into a single raster data. The composite raster image was clipped using Obio/Akpor Area Council boundary. Maximum livelihood, supervised classification was carried out on the clipped images in the ArcMap and per-pixel shows: wetland and water bodies, built up area, The borders of the area; Eneka, Rukpokwu, Atali, Rumuawholu, Rumuolumeni and Mgbuoshimini were saved using Google Earth as a Kmz file and converted to a layer on ArcMap using the conventional tool.

The classified raster image was reclassed and then converted to polygon, whereas to ascertain the percentage change and magnitude of wetland loss from 1990-2019 a simple arithmetic was performed as shown in Table 3

From Table 3, the percentage alterations (depletions) in the various images/features classified in the GIS maps from 1990 – 2019 is shown. From 1990 – 1995, wetlands depleted by 79.2% in 1990 and by 83.3% in 1995 as presented below.

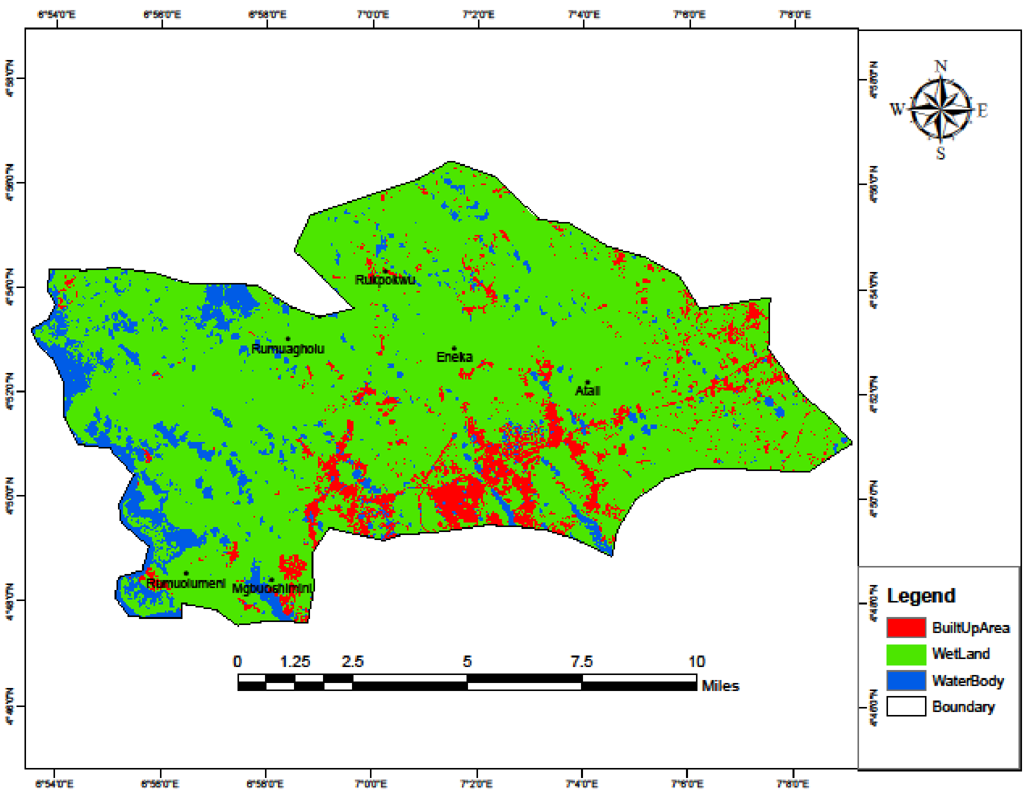

Figure 3: Land use cover pattern of Obio/Akpor in 1990

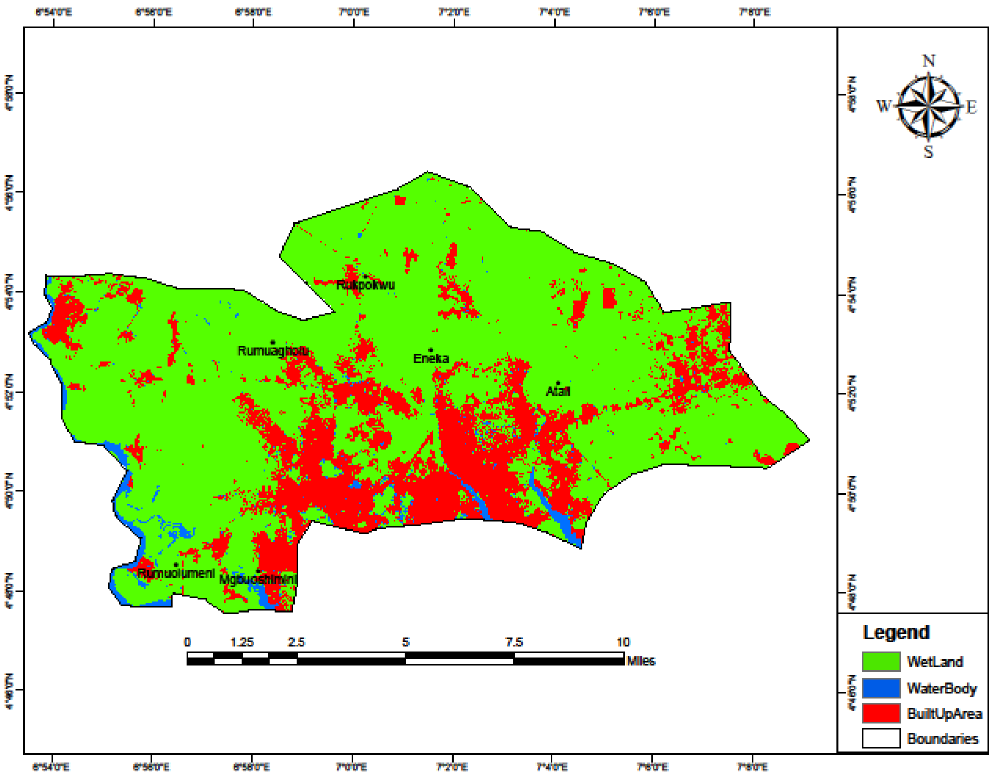

Figure 4: Land use cover pattern of Obio/Akpor in 1995

Also, wetland depleted by 86.2% in 1996 and by 71.3% in 2000 of the total wetland area as also shown below.

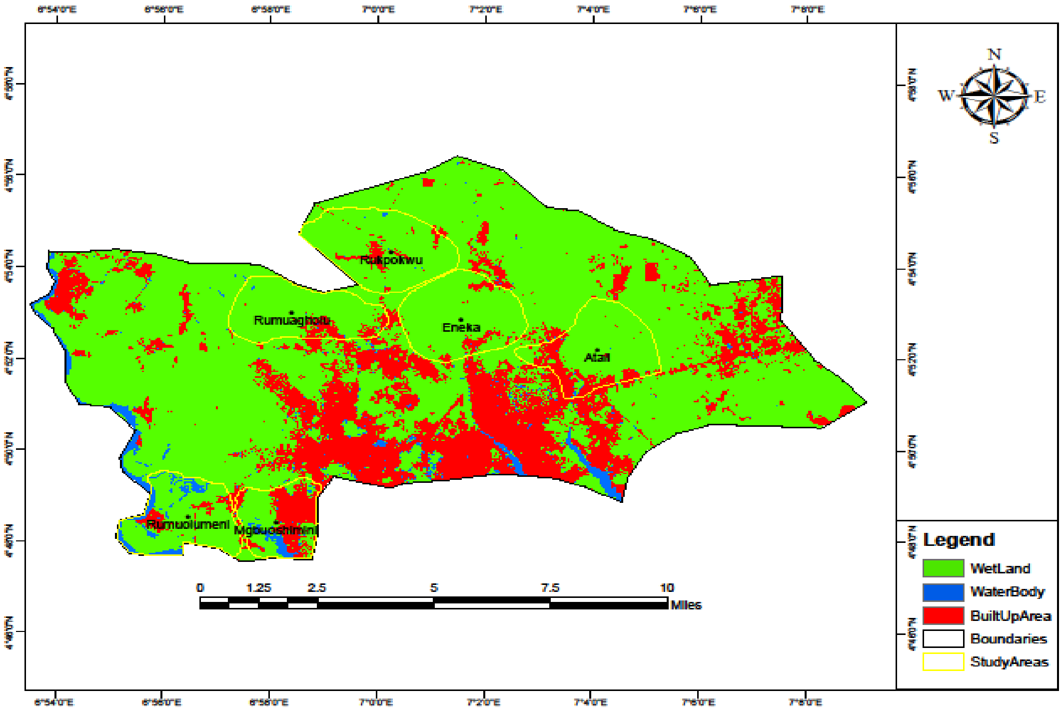

Figure 5: Land use cover pattern of Obio/Akpor in 2000

From 2005 – 2010, wetland was depleted by 28.8% in 2005 and by 30.8% in 2010 as presented below.

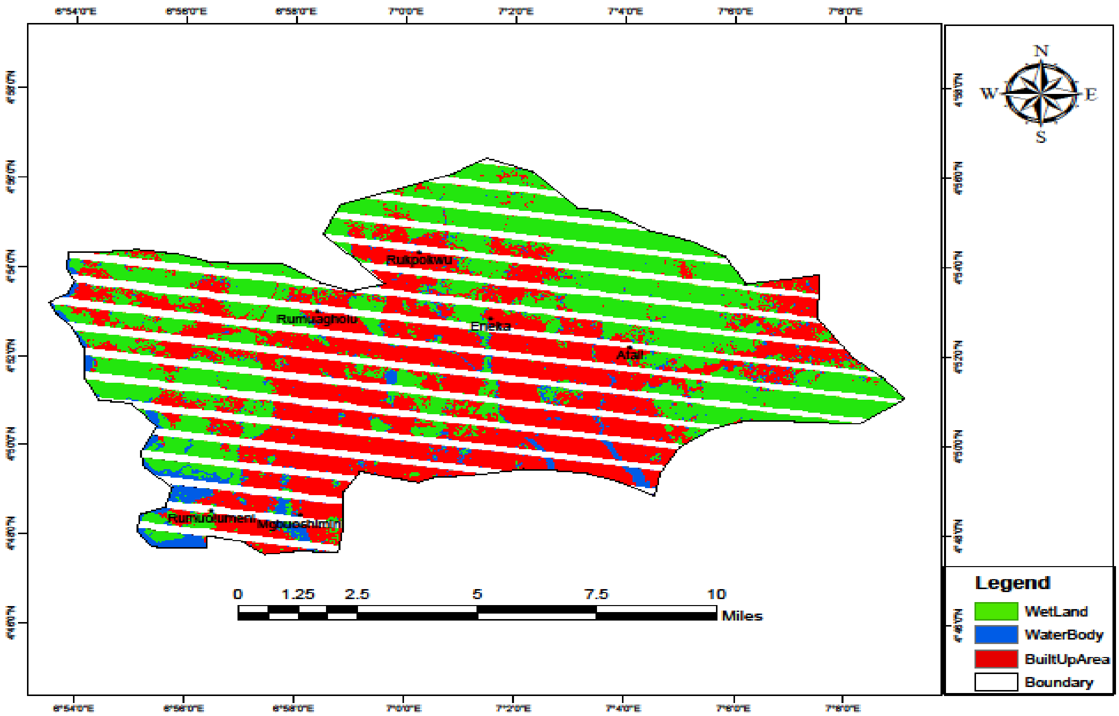

Figure 6: Land use cover pattern of Obio/Akpor in 2005

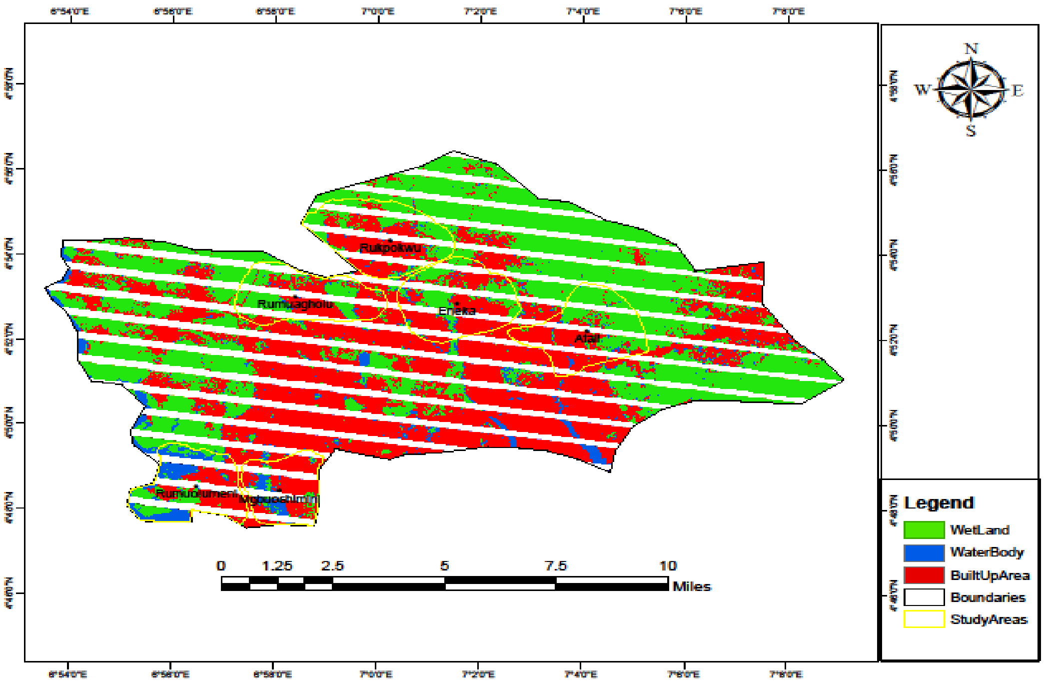

Figure 7: Land use cover pattern of Obio/Akpor in 2010

Again, wetland was depleted by 12.1% in 2015 and by 18.7% in 2019 as shown below.

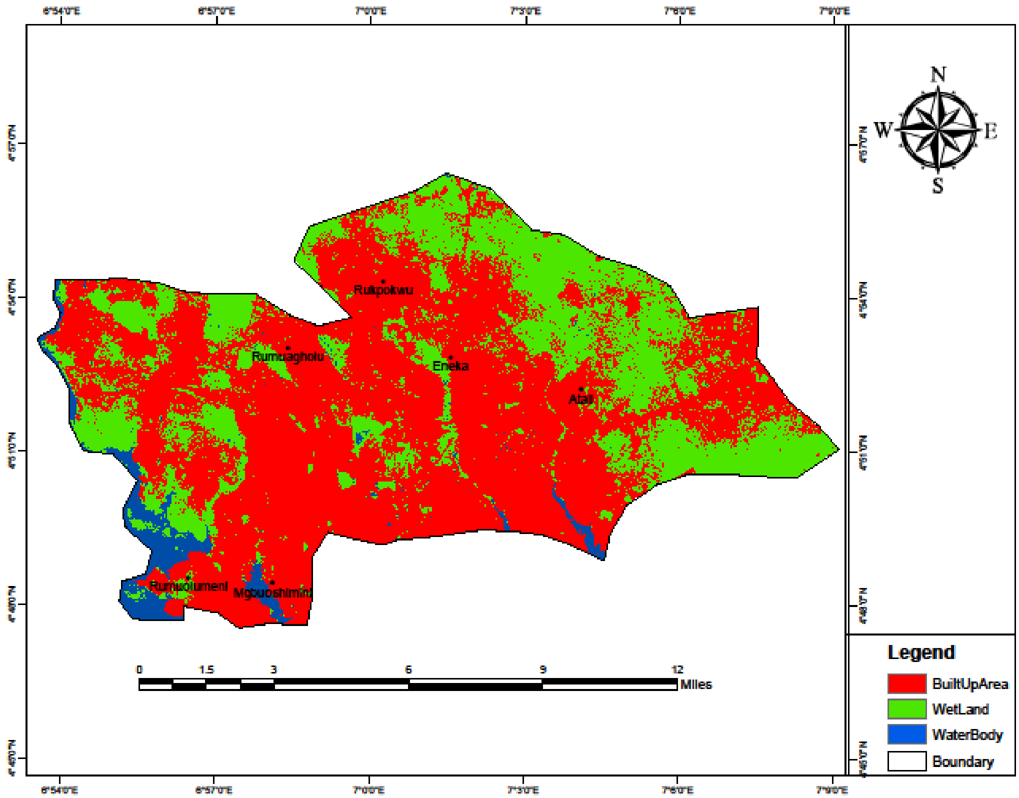

Figure 8: Land use cover pattern of Obio/Akpor in 2015

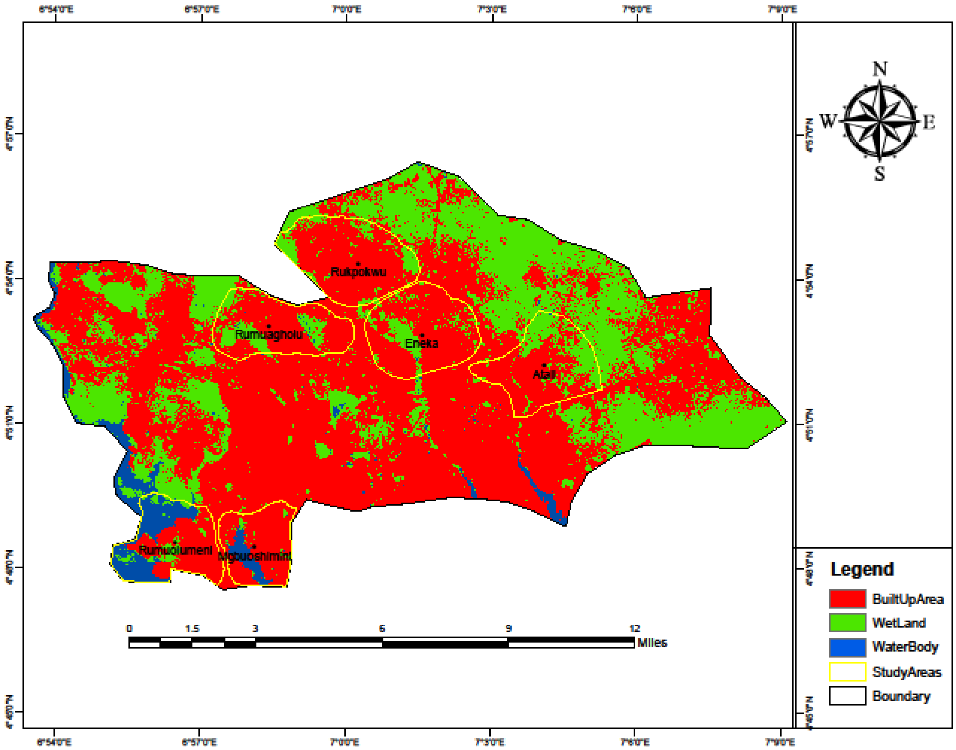

Figure 9: Land use cover pattern of Obio/Akpor in 2019

In the Table 3 and in Figures 3 and 4 above, water bodies was depleted by 7.4% in 1990 and by 6.2% in 1995. From 1996, water bodies was depleted by 4.3%, in 2000 by 2.8% as presented in Table 3 and depleted in Fig. 4 and Fig. 5. In Table 3 and in Figures 5, 6 and 7, water bodies was depleted by 20.7% in 2005 and by 13.3% in 2010. Water bodies was depleted by 18% in 2015 and by 4.7% in 2019 as presented in Table 3 and as presented in Fig 8 and Fig. 9.

Lastly, in Table 3 and Fig. 3, in the converted wetland area, built up areas increased by 3.7% in 1990. In 1995, it increased by 10% (Fig. 4). From Table 3 and Fig 4 built up area expanded by 17% in 2000. It rose by 30.7% in 2005 (Fig 6) and by 55.3% in 2010 (Fig 7). Also built up areas expanded by 62.3% in 2015 (fig. 8) and by 74% in 2019 (Fig. 9).

Sustainable Management of Wetland for Environmental Sustainability

On the sustainable wetland management strategies for environmental sustainability was in the area, the survey data generated shows some sustainable wetland management measures. This is shown in Table 4.24.

Table 4: Distribution of sustainable wetland management

S/N	Sustainable wetland management option	F	%
a.	Protection of riparian and butter zone vegetation	35	9.6
b.	Holistic and integrated approaches like community base involvement in the wetland management and preservation	30	8.3
c.	Restoration of polluted wetland site	38	10.5
d.	Establishment of urban wetland protection authority and laws	26	7.2
e.	Controlled urbanization and environmental education	36	100
f.	Reduced rural-urban drift	30	8.3
g.	Enforcement of urban development control practices	34	9.4
h.	Declaring some wetlands Ramsar sites	33	9.1
I	Protection of cultural sites for preservation/ protection of biodiversity and sacred cave-water body system	35	9.6
j.	Carrying capacity studies for the wetland area	30	8.3
k.	Demarcation and mapping of wetlands areas and water bodies	36	10.0
	Total	**363**	**100**

Source: Field Survey, 2020

From Table 4 above, it was revealed that polluted wetland site recovery (10.5%) is a significant endurable wetland management practices to be used in the reclaimed wetland area for settlement in the study area. Also, controlled urbanization and wetland areas and water bodies demarcation and mapping as out of bound areas with 10.0% of the respondents respectively. Also, riparian and buffer zone vegetation protection and the cultural sites safeguarding for biological diversity preservation/protection of revered cave-water body system with (9.6%) respective and the enactment of city development control regulation / practices (9.4%) are other wetland management endurable practices. Reduced rural-urban drift and the wetland area carrying capacity research (8.3%) respectively are other measures. Declaring some wetland regions/site Ramsar site with 9.1% of the respondents is another wetland management endurable option, and lastly, the setting up of urban wetland protection authority and laws (7.2%) is another wetland management endurable measure.

Conclusion and Recommendations

It is worthy to say that this research has helped to provide the needed framework for the sustainable wetland management for environmental sustainability in Obio/Akpor Local Government Area of Rivers State. Thus, it has shown that the causes of wetland depletion include rapid urbanization, urban sprawl and expansion, increase urban population and the need for housing and other facilities development etc. The lack of strong legislations for urban development control agencies has created ample opportunity for the encroachment on the available wetland areas thereby creating great impact on the socio-economic, ecological and environmental fortunes of the urban area.

It is evident from the study that the spatial extent of wetlands depletion increase overtime, and this is due to the fact that wetland is being converted to other land uses which include farmland and built up areas. Thus, it can be concluded that there is the need for development control and strong legislation to be put in place to ensure the existence of wetland ecosystems in the area. Also, planning agencies in the urban system and the creation of awareness on the importance of wetland and its sustenance is necessary to the extent that community base participation and involvement in wetland management practices be evolved. Thus, human activities and high rate of rural-urban drift should be curtail through regional and rural development initiatives. The study therefore recommended that: Human activities depleting wetland should be drastically reduced and efforts/activities that encourage wetland conservation should be enhanced by individuals and the government, wetland areas should be delineated and protected from further encroachment upon and a wetland map should be produced for the area and legislations passed by government to make them riparian or Ramsar sites, wetland biodiversity conservation efforts should be put in place in the area to protect and conserve the socio-economic, cultural environmental and ecological importance and value of wetland ecosystem, wetland protection and conservation authority should be established to checkmate encroachment on wetland and to enhance the functionality of wetland so as to address the perceptual impacts and implications of wetland depletion in the area and the establishment of urban wetland protection authority to checkmate human economic activities and encroachment on wetlands. This way, laws that will spill out punishments for defaulters will be enacted.

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